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YUKON GOLD-FIELDS



LETTER FROM

HENRY A. MIERS, D. Sc., F.R.S.,

Waynflete Professor of Mineralogy

...in the...

University of Oxford.



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The Hon. CLIFFORD SIFTON,
Minister of the Interior,
Ottawa, Ont.

DEAR SIR,—

The following brief account of my trip to the Klondike, made this summer at your kind invitation, in company with Prof. A. P. Coleman, records some of the impressions of an English traveller to whom the country and its conditions were entirely new, and who visited it without any personal or professional interests.

I regret that the time which I spent in Dawson and its neighbourhood was too short to enable me to acquire much new information, or, indeed, to make more than a very superficial examination of the district. Owing, however, to the liberal provision which you made for our guidance and assistance, we were enabled to do more than could possibly have been accomplished by an ordinary traveller in the same time.

I feel sure that we could not have made our visit at a more interesting time ; the following account will, I hope, make it clear that a great transformation is now taking place in the district, and as regards the mining in particular, the old order is changing and giving place to a new one which can this year be watched in process of active development.

Our principal object being to study the mining methods and the auriferous deposits of the Klondike district, this period of eleven days was mainly occupied by a visit to the more important " creeks " or valleys which are being worked for gold, and we

left our official guide to make such arrangements as should best enable us to see as many varieties as possible of the mining operations. He arranged that we should drive in a four-horse conveyance through the principal creeks, under the guidance of a constable of the Northwest Mounted Police. I do not think that a more satisfactory method of making our tour could have been devised.

To visit the mining camp in this way has only recently been rendered possible by the newly constructed government roads, which were nearly completed at the time of our visit. These roads are the greatest boon to the country, and have been welcomed with much gratitude by all the inhabitants.

The following were the most important properties which we visited during our trip, including a preliminary day's drive, and a final day's expedition on foot :—

- (1) Messrs. Chute and Wills' claims in Gold Run.
- (2) Mr. C. C. Johanson's claims on Hunker Creek.
- (3) Messrs. Quigg, Cooke and Mizner's claims in Trail Creek, on Bonanza.
- (4) The Lewes River Mining and Dredging Company's operations in Bonanza Creek.
- (5) Messrs. Stewart, Chute and Corthoy's quartz claims, Lone Star and New Bonanza, on Victoria Gulch.

So much has been written about the Klondike district that the nature of the region and of the gold deposits is now fairly familiar, and most of what I can say on this subject is doubtless well known to you. I need not pause to describe the many signs of prosperity and stability which the traveller now sees in Dawson City—the large stores, the banks, the saw mills, the churches, the electric supply works, the vegetable gardens—because I feel sure that all these are well known to you. But, in order to omit nothing that may be of interest, I propose to give you a somewhat full account of all that I was able to see in the camp, and to write

as though you had no knowledge of the mines. Bearing in mind my object, you will, I trust, pardon this manner of presenting my impressions.

THE MANNER IN WHICH THE GOLD OCCURS.

The undulating district, of which the Dome is the centre, and which is intersected by the broad creeks known as El Dorado, Bonanza, Gold Bottom, Hunker, Dominion, Gold Run, Sulphur and Quartz, all radiating from that mountain, consists mainly of green micaceous or chloritic schists; one nearly white, soft variety is known as sericite schist.

These rocks have not yet been carefully studied, and little is known concerning their origin. Mr. McConnell, in his excellent "Preliminary Report on the Klondike Gold Fields," expresses the opinion that they are of volcanic origin, and have been derived from eruptive rocks, of which one was a quartz-porphry. They are rocks of such a nature that the existence of auriferous quartz in them would not be in any way surprising, although it certainly could not be predicted.

The subsidiary rocks of the district—the slates, limestones, graphitic schists, and the later eruptive rocks by which they are penetrated, as well as the diabase and serpentine of Moosehide Mountain, the granite of other parts within the auriferous area, and the tertiary beds by which it is surrounded—are enumerated and briefly described in Mr. McConnell's memoir. I observed several masses of the later eruptives in Hunker Creek, where they appear to include rocks of both acid and basic character; some present the appearance of quartz-porphyrries, etholotes, diorites, and possibly anorthosites. In some places, as at 10 above Lower Discovery, on Dominion Creek, the schist is in parts quite gneissoid, and is intersected by dykes of quartz-porphry and of diabase. There is at present no evidence to connect any of what I have here called the subsidiary rocks with the distribution of the gold. The schists and their contents are undoubtedly the

rocks which are of most importance as the possible source of the metal. But, as is well known, the productive material has, up to the present, been almost exclusively confined to the gravels of the valleys.

These deserve somewhat careful study, since two possibilities present themselves ; the gravels have either been derived from rocks of the same character as those now visible to the Klondike district, or they have been derived from rocks of a different nature which have been entirely removed : in the latter case there would be no particular reason to search for gold in the schists themselves.

I may say at once, that so far as I was able to see, the gravels contain nothing that might not have been obtained by the mechanical destruction of rocks identical with those which now constitute the main mass of the Dome and the surrounding heights.

Among the minerals which I have seen from the gravels are Magnetite, Hæmatite, Rutile, Pyrites, Graphite, Kyanite, Garnet, Cassiterite, Epidote and Tourmaline. These are all minerals which may well occur as constituents of the schists, few of them have suffered much alteration, and like the pebbles of the gravel, they show no signs of having been transported any considerable distance. The pyrites, indeed, is usually in perfectly sharp crystals, but it is possible that these have been derived from the undisturbed bed-rock. On Hunker Creek I saw also barytes, which occurs in the gravel, and mispickel from the schist.

The gold is generally flattened, but comparatively slightly worn. Although crystals, or even crystalline and dendritic pieces, are rare, those which have been found preserve in many instances almost their original sharpness of outline, and are neither broken nor much rounded.

In some of the creeks, on Hunker, for example, and notably, I believe, on Mint Gulch, the gold is very dark in colour ; closer examination shows this darkening to be merely due to a super-

ficial film of some black material, probably limonite, and does not point to any essential difference in the metal or in its origin.

Altogether there is nothing to indicate that the gravels and the gold which they contain have been transported any considerable distance, or have been derived from any rocks which differ from those now found in the district.

It is important to note in this connection that Mr. McConnell explicitly distinguishes certain gravels at the mouth of the Hunter and Bonanza Creeks which do consist of well-surrounded pebbles of rocks foreign to the gold-bearing creeks, and states that these are not productive of gold.

The Cassiterite (tinstone) which I saw was in rounded pebbles, and came from Dominion Creek, and from Nos. 43, 44 and 46 below Discovery, on Bonanza Creek. Native copper has been reported from a sluice-box on Bonanza Creek, but this report needs confirmation.

On Gold Run, a pale green material, which presents the appearance of decomposed epidote, is locally regarded as an indication of the pay-streak ; I am not able to say whether this has any genetic significance.

The conditions under which the gold is found may be distinguished (using four names familiar in the district) as those of :—

- (1) The creek claims.
- (2) The bench claims.
- (3) The White Channel, and
- (4) The quartz ledges.

(1) CREEK CLAIMS.

The gold here occurs in recent gravels which form the bed of the present streams of the creeks ; these gravels are covered by a thick layer of the boggy or peaty vegetation locally known as "muck," which has to be penetrated before the gravel can be worked ; this is done in one of two ways, either (1) a shaft is

sunk through the muck, and subsequently through the gravel, until bed-rock is reached, and lateral tunnels are then driven from this into the auriferous gravel ; the gravel must then be raised by windlass or hoist to the top of the shaft and there shovelled into the sluice-boxes ; or (2) the muck is stripped off and an "open cut" or quarry is worked into the gravel. The latter appears to be the more satisfactory, but the more expensive method. It can only be conveniently adopted on creeks which have a tolerable grade—say one of about 10 feet to the claim—if the gravel is to be shovelled straight into the sluice-boxes. Sometimes it is advisable to shovel away part of the overburden of gravel and to pass the lower portion into the sluice-boxes.

The difficulties of mining in the region are largely due to the presence of the coating of muck (sometimes more than 10 feet thick), which possesses a remarkable power of keeping the gravel beneath it permanently frozen throughout the summer. Sheets of solid ice, locally known as "glaciers," are sometimes encountered in the gravel, and these considerably increase the difficulty of the work, not only because they are hard to penetrate, but because they may, in melting, cause a collapse of the roof.

The creek gravels are those which were first discovered to be auriferous, and the manner in which the earlier work was carried on, by thawing out the gravel with hot stones or wood fires in the winter and washing it in the summer, has been often described.

(2) BENCH CLAIMS (AND HILLSIDE CLAIMS.)

The gold here occurs in older gravels upon the sides of the valley above the present level of the stream. Some of these are sufficiently dry to be unfrozen. In any case, the necessity of stripping is obviated by "drifting," or driving tunnels into the gravel from the face of the hillside.

(3) WHITE CHANNEL.

Of the "bench claims" which rise in successive tiers above

the creek claims, some are worked in a remarkable deposit of white gravel, locally known as the " White Channel " or " White-wash." This consists of pebbles of quartz and of white sericite schist. The soft schist is in flat rounded pebbles, but the quartz is largely in subangular boulders and pebbles, which have not been completely rounded, indicating quite clearly that the material has not been transported far, and has not been worn by water for a prolonged period. The white channel is sometimes more than 100 feet thick, and does not seem to attain an elevation of more than about 700 feet above the Klondike River ; at about this level it may cross the valley, and the creek gravel then consists of white-wash, as for example, at 12b above Discovery in Gold Run. It was pointed out to me that the creeks are seldom richly productive above their intersection with the white channel. The origin of this deposit is very uncertain ; a more complete knowledge of it would doubtless throw much light upon the origin of the gold in the Klondike region ; it would be particularly interesting to ascertain whether the gold exists in any quantity in the quartz pebbles themselves ; the quartz of which they consist does not appear to be mineralized to any extent, but has a " hungry " or unproductive appearance. At present the white-wash is only sluiced for the metal which lies between the pebbles ; the quartz itself has not been crushed for gold ; but in some of the nuggets gold is attached to, or encloses, quartz precisely resembling the pebbles in its aspect. There is, so far as I know, a remarkable absence of any signs of glacial action. It is the opinion of the local geologists that the white-wash has been produced by the torrential action of water, and it certainly presents an appearance in harmony with such an origin.

(4) QUARTZ LEDGES.

In the Klondike district, as in all auriferous areas, active search has been made for quartz veins, without which the gold production

can scarcely be a permanent industry. I saw several specimens of auriferous quartz showing visible gold which were said to have been brought from veins in various parts of the district, but was at first not disposed to attach much credence to these reports of rich quartz finds. Lenses and stringers of quartz occur at frequent intervals in the schists, and some of these may, of course, contain visible gold, although so far as I could see, they are little mineralized, and do not present a promising appearance. If, however, the quartz veins reported are of any extent, or contain gold in any uniform distribution, their importance cannot be over-estimated. Promising quartz has been reported from other parts of the Yukon Territory, for example, from the Big Salmon River, but I can say nothing about such finds from personal knowledge. I believe, however, that from 4,000 to 5,000 quartz claims have already been staked.

I was only able to visit one such occurrence in the Klondike district. At the head of Victoria Gulch, which runs into Dominion Creek, opposite to Gay Gulch, a tributary of Bonanza Creek, and at a height of about 2,300 feet above Dawson, has been opened what appears to be a true quartz vein showing nuggetty gold in abundance; this quartz is gossamy (or porous, and filled with earthy decomposition products of metallic sulphides) at the outcrop, and appears to be fairly mineralized, exhibiting both pyrites and galena; I was able to break up specimens showing visible gold and decomposed pyrites, and in some cases the gold is contained in the crystals of pyrites. There is a layer of clayey material, locally called "gouge," on what appears to be the hanging wall of the vein, and I saw gold being panned from this clay.

The quartz vein has been traced to a depth of more than 20 feet, and possibly for a distance of 400 feet along the hillside; the country rock is the usual schist, and a rock which appears to be a porphyrite exists within 4,000 feet of the locality. Dis-

coveries of similar quartz showing gold indications are reported from the Dome, which is, it must be remembered, of special importance as the source of the creeks included within the Klondike district.

One interesting feature of the quartz claims, Lone Star and New Bonanza, which I have just described, should be mentioned. The gold here is distinctly crystalline in character, and the crystals are of a peculiar form, having a triangular outline, due to the fact that they are octahedra, and in particular a remarkable variety known as "spinel twins"; now, it is significant that the gold found below in Victoria Gulch is also crystalline, and has precisely the same characteristic outline. I possess a very beautiful example from No. 7 Pup on this Gulch, given me by Mr. Tyrrell, and similar specimens of the Victoria Gulch gold, which I was kindly allowed by the manager to select from a sample at the Bank of Commerce.

Here, then, we have fairly convincing evidence that the gold found in a stream gravel is identical with that found *in situ* in a quartz of the schists at the head of the valley, and in this instance there can be little doubt as to the origin of the gold.

In addition to the above modes of occurrence, I should, perhaps, mention two others.

Shattered Bed-rock.—The bed-rock, consisting of chlorite and sericite schist, upon which the auriferous gravels of the creeks rest, is generally shattered at the surface, and in some places has been found to contain considerable quantities of gold. It is now customary to work several feet into the bed-rock and to wash this in the sluice boxes with the gravel proper. It is probable, however, that the gold of the bed-rock has only passed into it from the overlying gravels; there is no evidence that it really belongs to the bed-rock. This occurrence, however, has a considerable importance for the following reason; in the early stages of the placer mining this valuable source of gold was, no doubt,

almost entirely neglected, and the work was stopped as soon as bed-rock was reached. This fact will probably prove one of the inducements for working over again many of the claims which have been supposed to be worked out.

The Indian River Conglomerate.—Considerable interest has recently been excited by the quartz-conglomerate discovered in large quantities in the Indian River. This interest, I believe, is mainly due to the supposed resemblance of the deposit to the celebrated “banket” of Johannesburg. In reality, there is no resemblance, beyond the fact that it is a conglomerate. I believe, however, that it is auriferous, and may, therefore, possibly prove to be a profitable source of gold in the future.

This is one more example of the curious but universal tendency of prospectors to seek only for what they have seen in other regions, and to assume that this and this alone is productive. The same spirit led the early prospectors to take up only creek claims or to stake quartz claims, and to turn their backs upon the richly productive bench claims and white-wash, which were new and, therefore, unattractive to them : a similar spirit leads them now to search in the Yukon Territory for Johannesburg banket and Cripple Creek tellurides, at the risk of ignoring other possible occurrences of the precious metal.

THE MINING METHODS.

My visit was made at a particularly interesting time, for although the older crude methods of placer mining are now giving place to more systematic and more economical methods, yet the former are still employed on some of the gulches, or where a claim or portion of a claim is being worked by one or two men on a small scale ; at the time of my visit it was possible to see both the old and the new systems in operation side by side, and to compare them, and so to obtain very striking evidence of the great improvements which have been introduced even during the past

year. I shall mention very briefly the old methods, which have been often described, and do so merely for the purpose of emphasizing the changes which are taking place. In this connection it will be convenient to consider separately the creek claims and the bench claims.

I. Creek claims. (a) *The old methods.*

STONE THAWING AND FIRE-SETTING.

Although it is possible by the method of 'open-cuts' worked in summer to thaw the frozen gravel by leaving it exposed to the sun, yet since this process is a lengthy one, and can only be pursued in the summer months, it was the custom in the early days to sink a shaft by means of hot stones, which, being dropped into the shaft, heated the water at the bottom, and so gradually thawed the gravel down to the bed-rock. Even this primitive method (which was probably derived from the Indians) can still be seen here and there.

Subsequently, it became the custom in sinking shafts or in working out the gravel from the sides of the shafts to thaw the ground by 'fire-setting'; in this process a layer of dry wood is piled up against the face of the gravel, blanketed behind by a layer of green wood, ignited, and allowed to burn itself out; the method may now be seen in operation upon some of the smaller gulches; it is clearly a primitive, laborious and expensive process.

The fires were usually laid in the evening, and the thawed gravel was worked out next day, but one fire would not thaw much more than a foot into the rock-face.

The spruce of the Klondike appears to be a wood admirably adapted for fire-setting, and leaves very little ash.

Mr. Treadgold (Report on the Gold Fields of the Klondike, 1899) estimates that one cord of wood (128 cubic feet) is required for every 4 cubic yards of gravel drifted, and I was told that this wood at the present time costs at least \$10 to \$12 a cord, or even as much as \$16 to \$18 a cord on some of the creeks.

Windlass and Rockers.—The thawed gravel was raised by a hand windlass, in buckets of about one cubic foot capacity, and then washed out by the primitive hand ‘rocker’ familiar in the early stages of placer mining in most countries.

The gravel could be washed as soon as raised in the summer ; in the winter it is, of course, necessary to “dump” it in a heap at the mouth of the shaft ,and to wash it in the following spring, when water is available.

During the first period of the Klondike mining, these methods were well adapted for the rich claims which were then worked by single miners, or only two or three acting in partnership. I was told of a case in which \$75,000 had been washed by two rockers in one winter, and \$1,000 a day were rocked out on French Hill, where mining in the white channel was commenced.

Treadgold estimates that two miners cannot get more than between three and four cubic yards of ‘dirt’ on to the dump in a day ; and that with a rocker they can only handle something less than three cubic yards a day.

These primitive methods still prevail where the ground is let out on a ‘lay,’ i.e., where the owners of a claim let a portion of it to two or three miners to work, and receive from them one-half of the gross output.

(b) *New Methods.*

Let me now contrast with the above the methods employed this year by the larger owners of claims who have capital and labour at their disposal, and on ground which could scarcely be worked at a profit by the older methods.

Steam Thawing.

Chief among these is the thawing by steam ‘points,’ a process which has largely replaced the old fire-setting. The ‘points’ are four to six foot lengths of iron or steel piping, having a diameter of three-quarters to one inch, and terminating in a sharpened end of steel tube, through which steam is forced into the gravel at

a pressure of about 120 pounds. Iron pipes are preferred, since they are less liable to snap than those of steel. A hole is made by driving an iron bar into the ground, and the point being inserted into this hole is allowed to remain in operation for a period of from six to twelve hours, being driven in from time to time by light blows of a hammer ; the steam supplied from a small boiler enters the pipe at the side near its upper end, and so-called fire-proof gloves are worn by the men who handle the pipes.

One ' point ' is generally used to about each square yard, and from two to four points are required in the construction of a shaft measuring 4 by 8 feet ; each point is sufficient to thaw from two to four, or even five, cubic yards of gravel. The thawed gravel can then be worked by pick and shovel, transferred to barrows or buckets, and raised by windlass or steam hoist, either, in winter, to be dumped on to heaps for summer work, or in summer to be emptied straight into the sluice-boxes. The points are then inserted into the next layer of frozen ground, and the process is repeated. An innovation which, I believe, has been recently introduced with success, is to thaw right down to the bed-rock by means of long points before removing the gravel.

The advantages of this method over the old fire-setting are obvious ; one of the most important is that the obnoxious, and even dangerous, fumes that accompanied the fire-setting are entirely avoided ; from accounts given to me on the creeks it appears that carbon monoxide is the fatal gas which has so often produced suffocation in the shafts. With the fire-setting, the additional danger was incurred of thawing the roof of the underground workings by the smoke ; these are often chambers as much as 100 feet square, and are not timbered, so that any softening of the frozen roof is most disastrous.

Drifting is generally carried out in four directions from the shaft, along the surface of the bed-rock, and is opened out in a fan-like manner towards the limits of the claim ; the outermost

portions are worked first, and as the excavation is carried back nearer to the shaft, the roof and overlying muck-cap are allowed to cave in and settle down on to the bed-rock. Timbering is thus entirely avoided. The absence of timbering in the Klondike shafts and tunnels must be a very striking difference between the mining in this country and in Siberia, where very similar conditions prevail ; from published accounts it appears that a very elaborate timbering is employed in the Siberian mines.

It is clear, however, that a method involving the use of a boiler and steam-piping, in a district where materials and transport are so excessively expensive, is only possible for individuals or companies supplied with a considerable capital. The points alone cost, I believe, \$10 each.

PULSOMETER THAWING.

During the present year, a still newer method has been introduced by large miners on their claims on Gold Run ; they use a pulsometer pump and thaw out the ground by means of water forced into it in place of steam ; it is claimed for this method that, at any rate on some claims, it is more expeditious and more economical than the steam points ; the high pressure boiler is not necessary, the water can be used over and over again without delay, and the absence of steam in the air is an additional advantage. It is quite possible that the pulsometer may come into very general use next year.

SELF-DUMPING BUCKETS.

On most of the ground which is being worked on a tolerably large scale, the old-fashioned bucket and hand-windlass have been replaced by a steam hoisting plant, which raises the gravel in buckets to the winter dumps or to the sluice-boxes. A still further economy of labour has been introduced by the use of ' self-dumping ' buckets, now employed on many of the creeks. In this ingenious contrivance the bucket is suspended from a hook, which

is caught by a small travelling frame as soon as the bucket reaches the necessary height above the shaft ; this travelling frame is held fast by a clutch, which is released when struck by the hook of the bucket ; by this act the bucket attaches itself to the carrier and is drawn by the hoist rope along a horizontal wire rope to the dump, where it is automatically tilted by a catch, which lifts the bottom of the bucket and empties the contents. By means of this simple contrivance it is not necessary to have more than one man, the engineer, above ground ; and the self-dumping hoist will raise as much as 1,400 wheelbarrows, corresponding to about 100 cubic yards of gravel, whereas, 1,000 wheelbarrows a day is as much as can be drawn by the windlass ; further, the windlass is a fixture at the mouth of the shaft, whereas the self-dumping hoist is easily shifted to any convenient spot.

DREDGING.

An entirely new type of creek working has recently been developed by the introduction of a large dredging plant at 42 below Discovery on Bonanza. This dredge was employed successfully by the Lewes River Mining and Dredging Company two years ago on the Cassiar Bar, where it used to work about 1,000 yards a day. A dredge can, of course, only be used in ground which is not frozen, and is either free of or has been cleared of overlying muck ; the experiment is, as yet, too new to allow of an estimate as to its efficiency or economy ; but I venture to think that much of the gravel of the worked-out claims which were left by the earlier miners as unprofitable for their cruder methods, might well be worked by dredging. I was able to see this dredge in active operation, and obtained the very rough estimate, that as much as 2,000 yards a day might be treated under advantageous conditions, and that it would occupy twelve men more than ten days to handle the same amount. It appeared to be working not only down to, but well into, the bed-rock.

SLUICING.

Finally, the old-fashioned rockers have been almost entirely replaced by large wooden sluice-boxes, provided with wooden riffles, by which the gold and the other heavy minerals are retained. These sluice-boxes are generally made in 12 feet lengths, and have a width of 10 inches at the top and 8 inches at the bottom, or of 12 inches at top and 10 inches at bottom. Three types of riffles are employed, the 'Pole riffle,' consisting of longitudinal bars set parallel to the length of the box, the 'Hungarian riffle,' consisting of transverse bars, or the 'Auger riffle,' consisting of a plank with a number of circular holes bored through it. The pole-riffles are those most commonly used.

As regards the inclination or tilt of the sluice-boxes, it is found that a low grade is not satisfactory, but that a fall of 7 to 9 inches in the 12 feet box-length is necessary. The sluice-boxes are, as usual, narrower at one end than at the other, and fit into each other.

The boxes are burnt after they have been in use for some time, and begin to be worn out, and yield about an ounce of gold apiece.

Mercury is only very rarely used to catch the fine gold; it is sometimes placed in the holes of the auger-riffles, but the miners of the Klondike do not appear to attach much value to its use.

As regards the flow of water, a sluice head of 75 miner's inches is generally employed—a miner's inch in the Klondike being equivalent to $1\frac{1}{2}$ cubic feet of water per minute.

The water, which is scarce in the district, and must be used economically, is conducted to the sluice-boxes in wooden flumes, which are often as much as half a mile in length in the flat creeks; their construction and maintenance is a serious item of expense, considering that the cost of the wood suitable for this purpose is about \$110 a thousand; and not long ago it might be as much as \$1 a foot.

In some of the wide valleys, where the pay-streak is on the opposite side to the present stream, for example, on Gold Run, it is necessary to transfer the water from one side of the valley to the other for use in the sluice-boxes ; this is done by long flumes, and here, as in places where there is a difficulty in obtaining water from any considerable distance up the valley, it is raised by means of centrifugal pumps to a height of about 40 feet. On No. 12 below Discovery, or Gold Run, for example, I saw a pump making 500 revolutions per minute, driven by a traction engine with supplementary boiler, at a pressure of about 140 pounds. This is sufficient to supply about 2,000 gallons per minute—say three sluice-heads of water—to the other side of the valley.

I enjoyed the privilege of witnessing a 'wash-up' on one of the large claims on Gold Run ; the riffles are taken out, beginning with the uppermost, and a sufficient stream of water is sent down the sluice-boxes to wash away the fine gravel which has been caught with the gold and the heavy 'black sand' that accompanies the latter. A large boulder is placed in the boxes here and there to check the flow of water where desired, and the gold accumulating in little yellow heaps at such spots is a very pretty spectacle.

The gold and black sand are held by the rough surface of the wooden sluice-box, and having been carefully brushed up and collected, are taken away to be separated.

For this purpose the material is passed through a triple sieve box, consisting of an upper sieve with coarse meshes, which retains only the larger grains of pure gold, and two lower sieves, with finer meshes, through which the gold and black sand pass together. A great part of the black sand is magnetic iron ore, and can be more or less completely separated by passing a magnet through it ; on some claims, for example, at 13 above Discovery on Gold Run, the black sand consists practically entirely of magnetite, and can be separated by the magnet alone ; but in general,

there is, together with the magnetite, a considerable proportion of ilmenite, which, though weakly magnetic, is not held by the magnet, together with a little pyrites, and possibly also, some rutile.

The final separation is, therefore, effected by means of a triangular metal tray, open at one corner, and known as a 'blower,' in which the material is carefully shaken and blown by the mouth until the ilmenite, pyrites, and remaining magnetite are all blown away, and nothing but the pure gold dust remains.

This is a somewhat lengthy and laborious process, and might advantageously be replaced by some mechanical device.

2. THE HILLSIDE AND BENCH CLAIMS.

(a) *The Old Methods.*—These high gravels were formerly worked on much the same lines as the creek claims, with fire-setting and rockers ; the water having to be brought up from the creek in buckets ; the difficulties were, therefore, much greater than in the creek claims.

(b) *The New Methods.*—At the present time the appearance of such hillsides as Cheechaco Hill and Adams Hill, with their long rows of adits, their large heaps of tailings, and their inclined tramways descending to the bottom of the valley, is one of the most remarkable features of the region.

When the visitor views these busy mining operations and realizes upon what a scale the driving of tunnels into the hillside is being carried on, he can scarcely believe himself to be in a placer mining district.

Drifting.—Of the hillside properties none, perhaps, is more systematically worked than that situated in Trail Creek, above No. 80 below Discovery on Bonanza, which I had the opportunity of visiting under the guidance of one of the owners. This, I may well take as an illustration of the extent and richness of the upper gravels, especially of the white-wash, and of the veritable mining which is now being carried on in them.

The work is here carried on entirely in the white channel, into which a horizontal tunnel 700 feet in length has been driven; at right angles to this, and at intervals of about 60 feet, lateral tunnels were being driven to a distance of 70 feet on either side; there are, I understand, about 200 feet of pay gravel above the level of the tunnel, which yield 5 cents to the pan even in the upper parts.

The white channel is estimated to be 1,400 feet in width. The gravel is here so compact that timbering has been found quite unnecessary except where the cross-cuts intersect the main tunnel, and there only for the purpose of convenience. Nothing in the whole mining conditions of the Klondike seems more strange than the almost total absence of timbering; in the creeks this is, as was mentioned above, rendered impossible by the frozen ground and muck which form a solid roof to the underground chambers and tunnels; on this hillside group of claims it appears even more remarkable, for the ground is too dry to be frozen. In other respects the working really resembles the ordinary mining of other countries and of other metalliferous deposits; and the illusion is here complete when one sees the long tunnels, the men working with pick and shovel, and the cars of rock being wheeled out to the head of the long wooden shoot which carries the gravel down to the creek. (In many properties an inclined tramway is used.) With mining of this systematic character, it is possible to gain some idea of the approximate cost and speed of working. It was estimated by one of the owners, that in a day's work each pick can take out about 14 car-loads of material; each car has a capacity of about 75 pans, 7 pans being equivalent to about one cubic foot of the 'white-wash' after the larger boulders have been removed, and that this can be done at a cost of about 50 cents per cart-load; it requires three men to handle the gravel from twelve picks. It is clear that if the average value of the white-wash be taken as four and a quarter cents to the pan, this leaves a handsome margin for profit.

Hydraulicking.—If the last example affords an excellent object-lesson of the manner in which the old, crude placer methods are being replaced by systematic mining, I have next to mention another even more striking instance.

Two great obstacles in the working of the bench claims are (1) the difficulty of disposing of the tailings, which cannot be allowed to slide down on to the creek claims below, but must be artificially banked up on the hillside, and (2) the difficulty of obtaining water at this height.

The first difficulty is partially overcome by drifting in from the hillside, or from a shaft to the back limit of the gravel, excavating this portion of the underlying pay gravel first, and allowing the worked out part to cave in as the working is carried forward, as in the creek claims: the second difficulty is sometimes overcome by pumping the water up from the creek.

Both difficulties have co-operated to prevent *hydraulicking*, which would otherwise be the obvious way of working gravels situated upon a sloping hillside.

Hydraulicking is, however, now being introduced in the Klondike region, and I paid a visit to the claims on Hunker Creek belonging to Mr. C. J. Johanson, who is carrying it on upon a considerable scale.

The water is derived from a reservoir in the creek, immediately beside the open-cut workings on his creek claims, and is raised by means of a 140-horse power engine to a height of 260 feet, the level of the hillside workings, and then to an additional height of 40 feet to an elevated tank, which gives a total fall of about 60 feet available for hydraulicking. The water is conducted through a 10-inch pipe and 6-inch hose, terminating in a 2½-inch nozzle. About 1,200 Canadian gallons a minute can be delivered.

This enables one man to wash out no less than 8 cubic yards

per hour—a great advance in speed upon the other methods at present used in the Klondike.

The gravel is washed straight down into large sluice-boxes which run down the hillside, and this, of course, dispenses with all the complication and expense of a hoisting plant, and with the labour required for transferring material to the sluice-boxes. Pole-riffles, consisting of bars slatted with iron, are here employed, and are cleared away every 24 hours. In the lower riffles pebbles and a little mercury are often employed.

As may be imagined, hydraulicking is at present an expensive process; it involves here a consumption of 14 cords of wood per day of 24 hours, 12 in the creek and 2 at the upper level; and if the value of wood be estimated at \$12 a cord in Hunker Creek, we are probably below the mark, for I was given to understand that it has at times been as high as \$30 per cord.

Other Recent Changes.—Among other improvements may be mentioned the supply of electric power and light, which has now been carried, I believe, to a distance of 13 miles, or from Dawson, by the company operating the electric power works in that city, and much facilitates pumping and hoisting operations. The same company is also, I believe, able to supply water to a considerable distance, at the rate of \$16 per sluice head, as well as the pipes for its conveyance.

Even in the more distant creeks, where electric light is not available, night work is largely carried on by means of the acetylene light.

Another new feature, and one which indicates some confidence in the future of the district as a quartz country is the erection of a crushing plant on the banks of the Klondike, in the immediate neighbourhood of Dawson, where a wood concession has also been obtained by the operators.

The plant which is now being erected is only, I believe, a two-stamp Tramaine mill, but it marks a new departure, and one of great significance.

It is much to be hoped that experimental crushings of the white-wash, and of samples of bed-rock, will soon be undertaken, since nothing seems to be known at present as to the amount of gold which may be contained in them, or, indeed, whether they contain any appreciable quantity of the metal.

Anyone who wishes to compare the present gold mining in the Klondike with that which prevailed two or three years ago, cannot do better than visit Mr. Johanson's claim in Hunker Creek, and contrast what he sees there with any of the published accounts of the Klondike which he may have read.

In the creek he could see, this summer, large open-cut workings carried to a depth of 20 or 30 feet, with numbers of steam thawers in active operation, groups of busy miners transporting barrows of the rich gravel to one end of the excavation, where they are raised by a steam hoist ; besides the workings, a reservoir of water, dammed in from the creek to supply the hydraulic plant on the hillside ; climbing the hill, he would find himself in a vast excavation, commanded by a pumping plant and an elevated tank, from which a large hose conducted a powerful jet of water upon the sides of the excavation ; masses of gravel rapidly crumbling beneath the stream of water washed away through a deep rock channel over the hillside, into a long succession of sluice-boxes, from the lower end of which a broad deposit of tailings spread itself over the bottom of the valley. Between the upper and lower workings, and beside the creek, he could see an engine-house, containing four boilers and engines, actively engaged in pumping the creek claims dry, and in supplying water for the hydraulic tank. Adjoining this, a smithy, where all requisites, from picks to horseshoes, are made upon the spot ; a saw-mill ; a boarding house and mess-room for the men, who number no less than 90 ;

wash-house, and even bath-room; and the excellent log house, which constitutes the owner's comfortable dwelling and business office.

Revisiting the creek at night, the traveller would witness the same restless operations, carried on by the vivid glare of the acetylene light.

THE PRODUCTION OF GOLD.

It is clear, from what I have said above, that the conditions under which gold is produced in the Klondike have changed very materially, and are changing rapidly at the present time; the introduction of machinery, and of more systematic methods, the acquisition of several adjoining claims by the same individual, or company, and the division of labour, ought to render it possible to work more economically, and to work ground which would not have paid miners using the simple methods of three years ago.

At the same time, and partly, no doubt, owing to these improvements, the output of gold has steadily increased.

And yet, the curious spectacle is now presented of the old crude methods, the fire-setting, the hand-windlass, and the rocker, still in operation side by side with the new and improved methods which I have described. They are to be found in operation principally in two places :—

(1) Upon some of the smaller gulches, where one or two men are working a claim in partnership; this, however, is really something of the nature of prospect work; it has not been advisable to go to the expense of machinery in such spots, where wood and water are, perhaps, scarce, until they are known to be really productive; meanwhile, they do yield a livelihood to thrifty men.

(2) Upon the creek and lower hillside claims, where miners are working upon a 'lay.

This curious system of lays, according to which the owner of a claim lets a portion of it on a 50 per cent basis, appears to be still rather prevalent; it amounts to a confession, that whereas two

men working with windlass can afford to pay half the gross output of their work to the owners, who merely pay the royalty for them, yet the owners themselves cannot afford to work the claim on a larger scale.

The system, of course, has the advantage that the owner is not compelled to perform the duties of an overseer, except in superintending the 'wash-up' from time to time, but it is clearly wasteful and expensive, leading only to the somewhat incomplete excavation of the higher-grade gravel, and leaving the lower grade material all the more difficult to work. Mr. Treadgold estimates that a 'layman' can only afford to work 25 cent dirt, i.e., gravel containing 25 cents to the pan, or 5 ounces of gold to three cubic yards of gravel.

The layman is, in fact, doing for the claim what the earlier miner has done for the creeks as a whole—working out the richer spots, and leaving the remainder to be worked by more economical methods at some future time ; and yet, the widespread introduction of machinery would seem to show that the time for this sort of thing is really past. The lay system prevails, I believe, mostly in winter, when men are looking out for work, and indicates another change which is being introduced into Klondike mining. Both on the creek claims and the hillside claims, signs are not wanting that, where systematic mining is carried on, the work is being more done in the summer and less in the winter ; the comparative rapidity with which the gravel can now be thawed, raised and washed, renders it unnecessary to store it in winter dumps for summer washing, and it is likely that work will be entirely abandoned in many properties this winter. Even the readjustment of the legal vacation in Dawson, according to which work will, I believe, be carried on throughout the summer, and holidays will be extended in the winter, points in the same direction.

But the present state of affairs also indicates that the equilibrium between the output and the cost of production is a fluctuat-

ing one, and that there are many claims which it does not pay to work on a large scale under present conditions.

The cost of working, and the sort of gravel which will pay, vary, of course, with the local conditions.

I was told that 5 cents to the pan may be taken as the average for pay gravel in the Klondike, but that the deeper workings in some creeks can be worked at 2 cents per pan.

If I may venture an opinion on matters which I have only been able to survey very superficially in a brief visit, it appears that, owing to the great wealth of the Klondike, progress has been too rapid, and that methods which must in the end prevail as the most systematic and economical, have been introduced before the cost of transport, of material, of labour and of the necessities of life, have been sufficiently reduced to meet them.

I have already mentioned some instances of the enormous cost of the mining; it is scarcely necessary to quote statistics, moreover, it is difficult to feel sure that they are really trustworthy. Signs of improvement are visible, however, in all these respects.

The initial cost of importing goods into the country seems to be diminishing; although freight rates amount to 6 cents per pound by the White Pass route; they have been, I believe, only 3 cents per pound by the St. Michael's route, and will, no doubt, be capable of reduction by either. I was told that the cost of transport from Dawson to the Grand Forks over the Ridge Road or the Lower Road, which was no less than 15 cents per pound in 1899, was 3½ cents per pound in 1900, and is only 1 cent per pound in 1901.

Timber which used to be one dollar a foot at Grand Forks is now \$110 per thousand for flume building, and is \$16 a cord for firewood. Fodder, which used to be \$1,000 to \$1,200 per ton, was obtained this summer at the rate of eight tons for \$1,000.

Still, it is certain that the expenses are nearly prohibitive; it is, no doubt, well known to you that wages of at least \$5 a day, and \$2.50 for board, are universally demanded and paid for unskilled labour, and that an eight-dollar wage has been stereotyped by its adoption as the scale of pay offered by the government for road construction, &c.

The miner's license of \$10 has, of course, to be paid for every one employed in mining, i.e., for every member of the camp except the cook; interest appears to be commonly charged at the rate of 5 per cent per month; the necessities of life are very expensive; the rent of a log cabin in Dawson is \$50 a month; and meat is still 50 to 75 cents a pound.

Some of the conditions tell more against the large operator than the small one; the 5 per cent royalty, for example, on an output above \$5,000; or again, the fact that the owner of thirty claims must so far subdivide his labour as to put in the necessary representative work upon each group of ten claims, instead of being allowed to concentrate his labour on one; also, the absence of any provision assisting an owner to acquire intermediate claims which intervene between isolated claims or groups of claims which he may hold.

Everything, however, is clearly tending in the direction of large operations, and towards the extinction of the small operator; the concessions which have been granted mark, no doubt, the opening page of a new chapter in the history of Klondike mining.

And yet, it cannot be said that the concessions have, as yet, been productive of the work which was expected of them.

When one takes into account the enormous wealth of the district, and the fact that, as I have endeavoured to show, it is losing the precarious character of a new placer camp, and is approximating to the conditions of ordinary mining, in spite of the absence of quartz; that, in fact, it is ceasing to be a poor man's camp, and requires extensive capital and labour for its develop-

ment; it is certainly remarkable that so many serious failures should have occurred, that so few of the mines have been worked at a good profit, and that the concessions should have hitherto failed to produce any great effect. It is a matter of common knowledge that the failures connected with English capital have been particularly disastrous; a peculiar fatality seems to have pursued English capitalists in the Klondike region; I heard it frequently remarked upon in the district and always deplored; that it was not necessarily due to want of judgment in selecting claims is clear from the fact that in several instances the very ground which failed to yield a return to an English company has subsequently been taken up and profitably operated by others. The workers on the creeks who are in a position to know are not only unanimous in confessing the fact, but, so far as I was able to judge, they are also unanimous in ascribing a cause to it. They declare that the men who were sent out to represent the interests of the English companies, either in many cases lacked the judgment and the stability of character which were needed, or had not the interests of their employers sufficiently at heart.

There is probably no place in the world where a young or inexperienced man may more easily lose his balance, spend his money and forget his business, than Dawson. From all accounts, companies which possessed really fine property were in some instances wrecked because their affairs were ruinously handled by their representatives. A short visit to the country is sufficient to convince anyone that these disasters did not take place because the district was poor, or in any sense played out, but that the capitalists have themselves to blame.

Nothing is more remarkable than to witness the successful operations of those enterprising men, who, without previous experience in mining, or even in the employment of labour, have come to the front as directors of large mining concerns involving the construction of machinery and the organization of labour.

Prominent examples are afforded by some of the workings to which I have alluded above.

Unless English and other companies realize that the conditions are new, and that in order to master them, energy, enterprise and adaptability are required ; unless they send out industrious men possessing these characteristics, devoted to the interests of their employers, and capable of profiting by the experience of the inhabitants, they will either fail to acquire good properties or will mismanage those which come into their hands.

There is an abundance of men in the Klondike who have proved themselves capable of mastering the new conditions, and there is room for many more.

SUMMARY AND OUTLOOK FOR THE FUTURE.

First, as regards the Gold.—Within the limited area which I have described, the auriferous creeks radiate from a centre; a glance at the map is sufficient to suggest that the gold has not been brought from a distance; this opinion is confirmed by the nature of the gold and of the gravel in which it is found. One very valuable source of gold is the remarkable deposit known as the White Channel, of which the origin is shrouded in mystery; it is, therefore, conceivable that all the gold of the creek claims has been derived from extensive deposits of this material which previously filled the valleys, and have been denuded away except upon the hillsides; it might be concluded that there is not much prospect of finding gold except in the white channel, or in the gravels derived from this deposit; it has already been pointed out that the stream gravels overlying the white channel do not contain much gold.

On the other hand, the materials (quartz and sericite schist) composing the white channel, are found in the country rock, and it is almost certain that this deposit is itself derived from the rocks of which the district consists.

Further, the gold is often found attached to quartz of the same character; on Hunker Creek I saw a nugget bearing sharp and distinct impressions of quartz crystals, proving unmistakably that it was derived from crystalline quartz.

These facts render the search for auriferous quartz somewhat hopeful, and the discoveries of the present year show that it undoubtedly exists in the schists of the Klondike. It remains to be seen how extensive the deposits may be.

As regards the Mining.—The conditions are rapidly changing. Machinery and organized labour are being introduced, and the camp is no longer a placer camp for the poor man. In fact, ordinary placer mining can only be seen now in some of the low bench claims on Dominion and Bonanza Creeks, where the conditions are so favourable that the gravel can, I believe, be worked as low as half a cent to the pan.

With more economical methods, employed on a large scale, ground should be profitably worked which has not been rich enough for the early miner, and, doubtless, herein will be ultimately included many of the creek claims which are supposed to have been worked out, and much of the tailings; the introduction of dredging and hydraulicking, to which I have called special attention, has been the first step in this direction.

The present almost prohibitive cost of *Transport, Material and Labour*, and the high standard of living, stand in the way of progress. The new government roads will do much to relieve the first difficulty, but in many respects the district has retained the abnormal peculiarities of a placer camp. Although a thrifty miner ought to be able to live on \$2 or \$3 a day, yet \$8 or \$10 is the rate of wages; the interest on loans is 60 per cent, and house rent is half the value of the house.

There is always a sense of insecurity about a placer mining region, and I have found outside the country a somewhat widespread impression that the Yukon Territory has seen its best

days, and will not long continue to be productive; I must confess that I shared this impression before visiting Dawson. A short stay in the country is, however, sufficient to convince a visitor that, even putting on one side the possibility of quartz mining, many of the properties now worked have many years of life left in them at the present rate, and that a comparatively small portion of even the Klondike district has been worked out. It may well be that the extravagantly rich deposits are exhausted, and that no second stretch of $3\frac{1}{2}$ miles upon a single creek will ever again produce from 25 to 30 million dollars of gold. Yet, even when the Klondike district is exhausted, there remains the whole Yukon Territory, which is certainly auriferous over considerable areas. The territory has been very imperfectly prospected, and prospecting in this country is very difficult on account of the vegetation. There is no reason why it should not ultimately yield other remunerative gold fields when the country has been opened up. Other resources are gradually revealing themselves; very fair coal is mined at Cliff Creek, about 55 miles below Dawson, and has been traced from that point to Rock Creek, on the Klondike, and possibly much further to the east. The coal mined on the Yukon, four miles above Five Finger Rapids, is said to be even better. A considerable amount of placer copper evidently exists up the White River, where it is said to be used by the Indians as bullets, and copper ores are reported from various localities, and notably (bormite, &c.) from the neighbourhood of White Horse.

Meanwhile there is an opening for honest, determined and industrious men, who will confront the unusual conditions of the country, and be prepared to live and work economically.

I have the honour to remain,

Yours faithfully,

HENRY A. MIERS.

